524

SEP 5 1950

SER. II, VOL. 12 *May, 1950* NO. 7

TRANSACTIONS
OF
THE NEW YORK ACADEMY OF SCIENCES

Editor
ROY WALDO MINER

Associate Editor
B. J. HENEGAN

Contents

The Precambrian—Cambrian Problem of East Newfoundland. *By* THOMAS N. WALTHIER 208

The Denes Action Method of Personality Development. *By* EMILY T. BURR 213

Some Recent Measurements of the Conductance of Dilute, Aqueous Electrolyte Solutions. *By* CHARLES A. KRAUS 215

Vero and Melbourne Man: A Cultural and Chronological Interpretation. *By* IRVING ROUSE 220

Mycological Problems in Deterioration of Military Equipment. *By* WALTER N. EZEKIEL 224

New Members 230

Copyright, 1950, by The New York Academy of Sciences

TRANSACTIONS of The New York Academy of Sciences, Series II, Volume 12, No. 7, May, 1950. Entered as second-class matter December 12, 1947, at the post office at Baltimore, Maryland, under the act of August 24, 1912. This publication is distributed to members and is published monthly from November to June, inclusive, by The New York Academy of Sciences, Mt. Royal and Guilford Aves., Baltimore 2, Md. Editorial office: 2 East Sixty-third Street, New York 21, N. Y.

Executive Director: EUNICE THOMAS MINER

UNIVERSITY OF MICHIGAN

THE PRECAMBRIAN-CAMBRIAN PROBLEM OF EAST NEWFOUNDLAND*

By THOMAS N. WALTHIER†

Newfoundland, the most eastern part of North America, is important in comparing the Paleozoic sediments of the New World with the type localities in the British Isles. The Cambrian and Ordovician are well exposed in many parts of Newfoundland and have been extensively studied.

The Structure of Newfoundland. In general, eastern and western Newfoundland are underlain by Cambro-Ordovician sediments folded along north-northeast trending axes. Folded Paleozoic strata also crop out along the coasts of Notre Dame and Bonavista Bays. The central and southern part of the island consists largely of granite with minor remants of folded Ordovician and Silurian sedimentary rocks. Throughout most of the island, the major folds are overturned to the west, and on the west coast they are arcuate in plan (FIGURE 1). The large, northern peninsula west of White Bay is anticlinal, exposing Precambrian crystalline rocks in the center, flanked by lower Paleozoic sediments. To the south, the Precambrian crystallines grade into schists and gneisses that are probably, in part, migmatized Cambrian sediments (Walthier, 1949: 14).

Several large thrusts have been recognized in southwest Newfoundland (FIGURE 1). The three western faults are known from field mapping (Cooper, 1936; Hayes & Johnson, 1938; Mook, 1926; Walthier, 1949, 1949a). However, the easternmost one is hypothetical. Its presence is inferred from high angle thrusts at White Bay (Heyl, 1937), and by the fact that Grand Lake lies on the strike projections in the granitic rocks to the south. This sixty-mile lake occupies a straight, narrow valley carved in the granites parallel to the faults at White Bay. Presumably, the valley represents differential erosion along a fault zone. The magnitude of the displacement shown on FIGURE 1 is conjectural.

Description of the Rocks of East Newfoundland. The basement complex of east and southeast Newfoundland is a thick sequence of acid lavas and tuffs, called the Harbour Main volcanics. It is composed of rhyolite, trachyte, and dacite, with minor amounts of andesite and devitrified acid glass. These rocks crop out over much

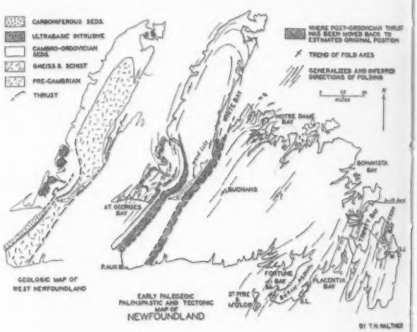


FIG. 1

of the area from the city of St. John's in the east to Fortune and Trinity Bays. At all the places studied, the lavas and pyroclastics are alike in appearance and stratigraphic position. Reconnaissance surveys suggest that similar type volcanics are continuously exposed between the mapped areas. For this reason, the Harbour Main volcanics are assumed to be everywhere of about the same age.

Overlying this volcanic material are sedimentary rocks separable into two large, complex divisions. The thickness of the older, unfossiliferous graywacke, sandstone, and shale division is highly variable and

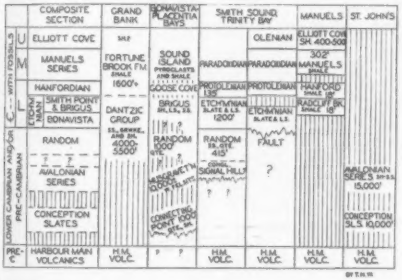
* This paper, illustrated with lantern slides, was presented at the meeting of the Section, April 3, 1950.

† Department of Geology, New York University, Washington Square, New York 3, N. Y.

may be subdivided by one or two angular unconformities. The dominantly shaly younger series carries abundant Lower, Middle, and Upper Cambrian fossils. In a few places, the two divisions are conformable; usually, they are not. The lower may be entirely missing, while in many localities the fossiliferous beds are absent, presumably largely because of post-Ordovician erosion.

FIGURE 2 summarizes the stratigraphic sections of six localities, arranged from west to east, in east Newfoundland. The Harbour Main volcanics are assumed to be all of the same age. The fossiliferous Cambrian sediments have been correlated paleontologically. These sediments, particularly the highly fossiliferous Paradoxidian beds of Middle Cambrian age are particularly favorable for correlation and have been carefully studied at Manuels by Howell (1925). The unfossiliferous sediments above the volcanics cannot be traced from map area to map area because of their highly variable character. Consequently, they have been shown (FIGURE 2) in their relative stratigraphic positions only. Thus, the Musgravetown Group and the Avalonian Series are not necessarily synchronous, although they do have the same relative stratigraphic positions in their respective areas. So, too, with the other unfossiliferous sediments. Vertical shading represents absence of sediments.

FIG. 2
STRATIGRAPHIC SECTIONS,
EASTERN NEWFOUNDLAND



At St. John's in the east (Hayes, 1931; Buddington, 1919), the Harbour Main volcanics are unconformably overlain by 10,000 feet of schistose sediments and lavas in the lower part and flint-like sediments, sandstones, graywackes, and tuffs in the upper part. Together, they comprise the Conception slates. (It is possible that the lower beds of the Conception slates are interbedded with the upper Harbour Main volcanics.) The slates are complexly folded, truncated by erosion, and overlain unconformably by 15,000 feet of black slate, sandstone, graywacke, and conglomerate of the Avalonian Series. The Avalonian Series is also folded and is now preserved in a large syncline (see FIGURE 3).

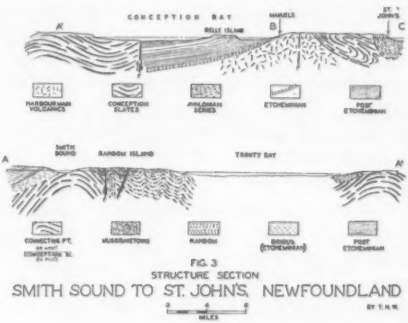


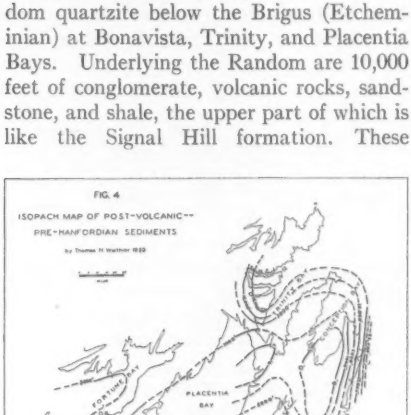
FIG. 3
STRUCTURE SECTION
SMITH SOUND TO ST. JOHN'S, NEWFOUNDLAND
MILES

Twelve miles due west of St. John's, at the fishing village of Manuels, fossiliferous brownish-black Cambrian shales lie unconformably on the Harbour Main rocks and a granite which is intrusive into the volcanics. These Cambrian beds have a well-developed basal conglomerate, with pebbles of the older volcanics and granite and a few limestone fragments.

More complicated relations are found fifty miles west at Smith Sound in Trinity Bay (Matthew, 1899; Walcott, 1900; Hayes & Rose, 1949). Below the highly fossiliferous Cambrian (*Protolenus* beds and younger) are shales and limestones carrying a meager, nontrilobite fauna. Matthew called similar sediments in New Brunswick "Etcheminian," and he correlated the beds in Smith Sound with those in New Bruns-

wick (1899: 42–53). The Etcheminian at Smith Sound is locally conformable with the *Protolenus* beds. More often, a disconformity is recognized between them, and at one locality Matthew found the two separated by an angular unconformity (1899: 50). Conformably beneath the Etcheminian is the Random quartzite. The oldest exposed beds of the latter are conglomerates resembling the Signal Hill division of the Avalonian Series at St. John's (Walcott, 1900).

Hayes and Rose (1948) found the Random quartzite below the Brigus (Etcheminian) at Bonavista, Trinity, and Placentia Bays. Underlying the Random are 10,000 feet of conglomerate, volcanic rocks, sandstone, and shale, the upper part of which is like the Signal Hill formation. These



latter sediments constitute the Musgravetown Group. Felsite lava forms a conspicuous part of the group. The contacts between the Musgravetown and Random and Random and Etcheminian are locally conformable, but in places unconformable. The geologic map of the area (Hayes and Rose, 1948, Plate 1) suggests slight overlap and offlap conditions in laterally shifting basins of deposition. The Connecting Point Group, the oldest rocks Hayes and Rose recognized in the area, consists of 1,000 feet of quartzites and shales. The Connecting Point and Musgravetown Groups are separated by an angular unconformity.

At Grand Bank, in the southern part of the Burin Peninsula (Walthier, report in preparation), fossiliferous Cambrian shales of the Fortune Brook formation* conformably overlie 4,000 to 5,500 feet of essentially unfossiliferous graywackes and shales of the Dantzic Group.* The latter rest upon the truncated folded lavas of the volcanic basement. De La Rue (1932) found a similar stratigraphic section twelve miles to the west on the islands of St. Pierre and Miquelon.

Tectonic Behavior during Precambrian–Cambrian Time. Over short horizontal distances, the thickness of the sediments lying between the Hanfordian beds and the Harbour Main volcanics varies rapidly. FIGURE 4, an isopach map of these rocks, shows no trend in the contours. The picture is one of small, oval and rectangular areas with little or no sedimentary rocks of that age, but in adjacent localities many thousands of feet of these sediments are found, such as under Fortune Bay, at Smith Sound, and around St. John's. These thick sedimentary sections may contain at least one major angular unconformity separating the sediments into older and younger groups.

Such abrupt changes of thickness, particularly where a rectangular pattern is formed, implies that eastern Newfoundland was not a structural unit during this time and that small segments of the crust were dominantly positive, while adjoining ones sank several miles. Some may have sunk more or less uniformly. The block near St. John's, however, subsided some two miles and was then folded. Uplight and erosion followed and still later a renewal of subsidence amounting to 15,000 feet formed a basin in which the Avalonian sediments were deposited. Later, the area was again folded.

The only known limestone in Newfoundland which could have supplied the limestone pebbles to the basal conglomerate at Manuels are the thin beds of the Etcheminian Series. During Lower Etcheminian time, the area around Manuels was being eroded, while, in some adjacent sinking

* New names.

area, mud and lime were being deposited. In late Etcheminian or early Hanfordian time the relations were reversed. The previously sinking area was rising and supplying limestone detritus to the Manuels basin, which was just beginning a long period of submergence. Here, then, is definite evidence of two adjacent areas with opposite and reversing vertical movements.

A structure section from Smith Sound to St. John's (FIGURE 3; adapted largely from Hayes, 1931, & Hayes and Rose, 1948) illustrates this variability in thickness of sediments in adjacent areas. It also shows that the greatest stratigraphic changes along the line of section occur at major faults. For example, the 10,000 feet of the Musgravetown Group thins to zero along a fault. This thinning did not result from later erosion, for the Random quartzite overlies the Musgravetown to the east of the fault while it lies on the Connecting Point Group on the west side. Since the Random is locally conformable with the Musgravetown, 15,000 feet of the latter cannot have been eroded to the west of the fault between the deposition of the Musgravetown and the Random. It would seem that the Musgravetown was never deposited to the west, and the inequalities in thickness along the fault zone are primary. The Conception slates also thin to zero rapidly along faults on either side of Conception Bay.

The geology for southeastern and eastern Newfoundland from Harbour Main to Hanfordian time is summarized thus: (1) rapid lateral change in thickness of sediments outlining local areas that acted as tectonic units independently of adjacent areas; (2) active volcanism, represented by tuffs and lavas interbedded with many of the sediments; (3) clastic sediments, with graywackes abundant and limestones rare, indicating moderate to high crustal instability (Krynine, 1948: 153); (4) local angular unconformities; (5) reversing positive and negative movements; (6) many sharp lateral changes of sedimentary thickness along major faults presumed to have been active during sedimentation; (7) granite intrusion is post-Harbour Main and pre-Hanfordian time.

This type structural-stratigraphic pattern has all of the characteristics associated with the Tertiary history of the Coast Ranges of California (Clark, quoted by Bucher, 1933: 310). A region having such a complex structure has been termed a heterogeneous mobile belt by Bucher (1933: 267) and is much like an epieugeosyncline (Kay, 1947: 1293).

To be certain that the pre-Hanfordian rocks of eastern Newfoundland represent the same type of structural conditions as those of the Coast Ranges, it would be necessary to know that the Newfoundland faults were contemporaneous with sedimentation and that much of the rapid stratigraphic changes occurred along such dislocations. This cannot be done, yet the abrupt change of sedimentary thickness across the known faults is good, but indirect, evidence that the faults were active during sedimentation and limited the basins of deposition. On the other hand, the known faults might represent later displacement along what were very sharp flexures during the deposition of the unfossiliferous rocks. Even so, the structural pattern would still be much like that in Southern California during the Cenozoic.

Correlation of the Unfossiliferous Sediments. Since it now seems likely that the tectonic history of southeast and east Newfoundland during the Cambrian, and perhaps earlier times, was like that of the Coast Ranges, the existing correlations of the pre-Hanfordian sediments in Newfoundland should be reviewed.

Many previous workers have assumed that a uniformity exists within the strata throughout eastern Newfoundland and that angular unconformities are of wide extent and everywhere approximately synchronous. With this assumption, an unconformity ought to be correctly correlated by its relative stratigraphic position. Moreover, rocks of the same relative age in two

areas should also be of about the same chronologic age.

From this account, it would appear certain that there is no uniformity and continuity to the sediments and unconformities of the pre-Hanfordian rocks in east Newfoundland. All evidence points to a unique history for each of the restricted areas. Consequently, rocks of the same relative age in two areas are not necessarily of the same chronologic age, nor is there any way to correlate these beds when only their relative age is known. When the intermediate areas have been mapped, it may be possible to trace some units across the different crustal blocks and establish a correlation.

The Precambrian-Lower Cambrian Contact. (a) *Nature of the Contact.* Precambrian rocks are usually defined as those separated by an unconformity from younger rocks carrying Cambrian (preferably Lower Cambrian) fossils. By such a definition, Precambrian rocks are extensively developed in east Newfoundland. Cambrian rocks are recognized by their fossil faunas. The boundary between Precambrian and Lower Cambrian rocks should be a time-stratigraphic boundary, that is, it should separate rocks of two ages, and, ideally, it should be synchronous throughout the world. To determine such a boundary requires precise correlation of the overlying and underlying rocks. Generally, the most effective methods in correlation are paleontological, and this is now the basis of all long-distance correlations of sedimentary beds. As Hedberg has pointed out, however, "Paleontologic features are at present the most useful means we have for extending time-stratigraphic surfaces, but even they are *always imperfect*" (1948: 455). Thus, even when dealing with fossiliferous sediments above and below a boundary, it is difficult, if not impossible, to establish the synchroneity of the boundary at all places. Unfossiliferous sediments are almost entirely unsuited for detailed time determinations. The lack of fossils in Precambrian sediments makes it impossible to establish that the Precambrian-Cambrian boundary is of exactly the same age in all parts of the world. In practice, it is usually placed at the first marked unconformity below fossiliferous Cambrian sediments. Thus, the base of the Paleozoic is fixed arbitrarily, although the character of the contact is often overlooked.

(b) *The Boundary in East Newfoundland.* In eastern Newfoundland, rocks carrying typical Lower Cambrian fossils are underlain, commonly unconformably, by unfossilferous sediments (Precambrian by definition). The unconformities are of such local extent in east Newfoundland, however, that the boundary placed at an unconformity in one locality would be practically impossible to trace into other mapped areas. Also, rocks considered Precambrian because they are unconformable beneath fossiliferous Cambrian sediments may be conformable with the Lower Cambrian beds a few miles away, where they would be regarded as part of the Cambrian system. It is evident that no criteria are available to distinguish precisely between Lowest Cambrian and the uppermost Precambrian in east Newfoundland. Strict application of the definition of Precambrian rocks gives anomalous correlations.

Although the Precambrian-Cambrian contact is generally regarded as one of the major boundaries in the geologic time scale, its recognition in east Newfoundland is elusive indeed. East Newfoundland seems to be a locality where Precambrian rocks merge into Lower Cambrian ones. Paleontologically, too, they are gradational. The oldest sediments are entirely unfossiliferous. These grade up into the sparsely fossiliferous Lower Etcheminian and finally into the abundantly fossiliferous beds of the Lower and Middle Cambrian.

References

1. Bucher, W. H. 1933. Deformation of the Earth's Crust. Princeton University Press.
2. Buddington, A. F. 1919. Pre-Cambrian rocks of southeast Newfoundland. J. Geol. **27:** 449–479.

3. COOPER, J. R. 1936. Geology of the southern half of the Bay of Islands igneous complex. Newfoundland Dept. of Natural Resources, Geol. Sect., Bull. 9.
4. DE LA RUE, E. A. 1932. Premiers resultats d'une mission geologique aux Iles Saint Pierre et Miquelon. Rev. Geog. Phy. et Geol. Dynamique. **V**, fasc. 4.
5. HAYES, A. O. 1931. Structural geology of the Conception Bay Region, Newfoundland. Eco. Geol. **26** (1): 44–64.
6. HAYES, A. O. & H. JOHNSON. 1938. Geology of the Bay St. George carboniferous area, Newfoundland. Newfoundland Geological Survey, Bull. 8.
7. HAYES, A. D. & E. R. ROSE. 1948. Geology of the area between Bonavista, Trinity and Placentia Bays, Eastern Newfoundland. Newfoundland Geol. Survey, Bull. 32.
8. HEDBERG, H. D. 1948. Time stratigraphic classification of sedimentary rocks, Geol. Society Am. Bull. **59:** (5): 447–462.
9. HEYL, G. R. 1937. Geology of the Sops Arm area, White Bay, Newfoundland. Newfoundland Dept. Natural Resources, Geol. Sect. Bull. 8.
10. HOWELL, B. F. 1925. The faunas of the Cambrian *Paradoxides* beds at Manuels, Newfoundland. Bull. Am. Paleont. **11** (43).
11. KAY, M. 1947. Geosynclinal nomenclature and the Craton. Bull. Am. Assn. Petroleum Geologists. **31** (7).
12. KRYNINE, P. D. 1948. The megascopic study and field classification of sedimentary rocks. J. Geol. **56** (2): 130–165.
13. MATTHEW, G. F. 1899. A Paleozoic terrane beneath the Cambrian. Ann. N.Y. Acad. Sci. **12** (2): 41–56.
14. MOOK, C. C. 1926. Note on the character of thrust faulting in Western Newfoundland. Geol. Mag. **63:** 348–350.
15. WALCOTT, C. D. 1900. Random, a Pre-Cambrian Upper Algonkian terrane. Geol. Soc. Am. Bull. **11:** 3–5.
16. WALTHIER, T. N. 1949. Geology and mineral deposits of the area between Corner Brook and Stephenville, Western Newfoundland. Newfoundland Geol. Sur. Bull. 35, Part I.
17. WALTHIER, T. N. 1949a. Geology and mineral deposits of the area between Lewis Hills and Bay St. George, West, Newfld, Nfld, Geol. Surv. Bull. 35, Part II.

*SECTION OF PSYCHOLOGY**

THE DENES ACTION METHOD OF PERSONALITY DEVELOPMENT†

By EMILY T. BURR‡

There are three objectives in the Denes Action Method. The first is to educate the public by presenting, through the dramatizations of actual case histories, some of the outstanding reactions of neurotic and maladjusted individuals whose roles are set in disturbing life situations. These case histories were dramatized by Gyula Denes, author and playwright from Budapest. The second objective is to indicate how this technique can be employed by clinical directors as a part of their regular program of group therapy. The final objective is to remove the stigma attached to mental disease by bringing to the public an awareness of the true nature of certain types of mental illness—to bring insight to the individual himself regarding his behavior and thus help him to alter his way of life. In this fashion, the public attitude toward mental difficulties may be so influenced that, whenever the seriousness of an individual's mental condition warrants it, early treatment and perhaps even the need for hospitalization will be recognized with no more opprobrium attached thereto than would be the case if he had an attack of heart disease or tuberculosis.

The Denes Action Method has two phases. (1) It presents dramatic incidents based on actual cases that are acted by professional actors and actresses and interpreted by a psychiatrist or psychologist. (2) It offers opportunities for persons in the audience to play roles in an unrehearsed, spontaneous presentation of personality problems in simulated life situations. Both phases of this action technique have proved to be highly successful in helping some persons to overcome their own personality difficulties and, by understanding better the difficulties of others, to remedy their unfortunate behavioral patterns. It is the

* There was no meeting of the Section of Biology in April.
† The meeting at which this paper was presented, April 17, 1950, was the first held in the new building of the Academy.
‡ Guidance Bureau, Psychological and Vocational Service, New York City.

opinion of many psychologists and psychiatrists that it is possible for a neurotic individual to achieve a definite degree of mental catharsis through witnessing such dramatic presentations as these, listening to the discussion of the theme, and perhaps participating in the discussion himself. The release of tension in the hitherto retiring individual who responds freely in a friendly atmosphere shows the efficacy of the method.

It is a truism that we evolve our standards and ideals out of our associations with others, but we cannot hope to arrive at maturity of judgment until we have acquired insight into the underlying motivations of these individuals and increased the depth of our own understanding of the principles of human behavior and the fundamentals of mental health. It is essential, in order to arrive at a recognition of the psychological factors inherent in each case, to note individual difference and to be ready with a happy, sensible response that will meet the needs of that person.

The psychological medium of dramatizing case histories is a form of entertainment that impresses an audience by its oral, pictorial, and emotional appeal. The human problems thus portrayed remain in the memory, as later interviews with persons who have witnessed the dramas have attested. The intensity of their interest shows how great a need there is for information regarding peculiarities of behavior and possible symptoms of mental disorder. There is a universal desire to know how to deal with personality disturbances in the home, in the schoolroom, and in business.

Dramatizing the human situations that arise in business is an effective method of demonstrating to clerks, sales persons, and executives how attitudes may be improved so as to bring about desirable employee-management and employee-customer relationships. This method has proved very successful. Such a form of educational procedure involves the use of the drama in business concerns as a specific method of training employees. Instead of the old-fashioned lecture procedure and all its "do's" and "don'ts," employees are given dramatic presentations of actual everyday office and store incidents enacted by attractive and experienced actors and actresses who put over their parts in truly professional style. Both desirable and undesirable methods of dealing with people are shown. Each play is followed by an explanation presented by an industrial psychologist familiar with business methods. Instead of being bored and restless, the employees listen attentively, and there are some who wish to discuss controversial points. Sometimes, different modes of behavior are put to vote, or an experienced employee may offer suggestions that will be acceptable to the group. This type of teaching is impersonal and gives the employee a chance to identify himself with the character whom he may most closely resemble or whom he may wish to resemble. Seeing his weak points, as well as his strong points, is enlightening. In nine cases out of ten, he will try to imitate the attractive actor's performance, for, in his heart, he longs to be "tops" in his job. Dramatizing his job glamorizes it. He is made to feel that doing his job well is rewarding.

Another way in which the shy, withdrawn, and introverted personality may become freed and responsive is through participating in the Denes extemporaneous drama, in which each person is given a part to play in the framework of a common situation. He must interpret his part as he sees fit. This gives him an opportunity for self-expression and for the development of spontaneity and initiative. It simulates a real life situation and demonstrates the need for alertness and quick thinking, since rarely does one have time to consider how to respond to unfamiliar demands. Such excrcises as this extemporaneous drama offers help to develop the free expression of ideas, to dissipate fear, to increase self-confidence, and to encourage a *savoir faire* that often results in positive personality gains. Inasmuch as those who take part in these spontaneous productions must quickly organize

their thoughts into pertinent remarks that will fit into the structural pattern established by the other participants, rapid and clear thinking is necessary. It means that co-operation of a high order is attained.

Children readily enter into an activity of this sort, and the method has proved eminently successful in dealing with young delinquents. In the Brooklyn Training School, the children ranging in age from 10 to 16 were asked to outline a play which they would enjoy acting. At once they suggested a case of truancy. Another time, they suggested the case of a girl unjustly accused of stealing a blouse. (When the owner of the blouse discovered that she had made a false accusation, she apologised for her mistake.) In all cases proposed by members of the delinquent group, a chance for free discussion under expert leadership was permitted. The right action was commended, and the children themselves volunteered to point out different ways of handling the situation. Getting the children to think out their own problems seemed to be a salutary method. The variations in behavior brought out a broad aspect of behavioral techniques. This educational method set up a dynamic pattern that was wholly practical.

The Denes Action Method of Group Therapy has many applications. It is not a substitute for psychoanalysis, which is too expensive for the individual of moderate means, but it has been extremely beneficial in cases of individuals showing minor mental and emotional disturbances. The theory back of the Denes Action Method is to prevent the development of unhealthy mental attitudes and to help individuals to acquire insight into the underlying causes of their difficulties so that a satisfactory personal adjustment may be made. In this way, it may become possible for them to see through the dark circumstances that apparently surround them and to achieve the personal sense of power that accompanies the capacity to control the self and so succeed in making a happy life-adjustment.

SECTION OF PHYSICS AND CHEMISTRY

SOME RECENT MEASUREMENTS OF THE CONDUCTANCE OF DILUTE, AQUEOUS ELECTROLYTE SOLUTIONS*

By CHARLES A. KRAUS†

The results here presented have been accumulated over a period of several years by a number of different workers in the Metcalf Research Laboratory of Brown University. The chief objective of these investigations was to determine the effect of the constitution and structure of ions on their conductance in water. The ions investigated include the symmetrical quaternary ammonium ions from tetramethyl- to tetra-normal-amylammonium, inclusive. Another series includes the unsymmetrical ions from ethyltrimethyl- to octadecyltrimethylammonium, inclusive, in steps of two carbon atoms in the long chain.

Since the salts of unsymmetrical long chain ions are colloidal electrolytes in water, with critical concentrations lying as low as $1 \times 10^{-4}N$ in some instances, it appeared desirable to improve the techniques employed in making up these solutions and in measuring their conductance.

Experimental Techniques. Measurements were carried out with solutions in a Pyrex cell of the Erlenmeyer type that had a capacity of 850 cc. of liquid. Salts were weighed out in quartz cups on a microbalance.[1] Manipulations with the cell, such as introducting water and salt, were carried out in a rubber-gloved chamber,

* This paper, illustrated with lantern slides, was presented at the meeting of the Section, April 18, 1950.

† Metcalf Research Laboratory, Brown University, Providence 12, Rhode Island.

within which the atmosphere was conditioned to have a constant content of carbon dioxide. This atmosphere was obtained by passing air through aspirator pumps and then through the gloved chamber.[2] Water in equilibrium with this atmosphere had a specific conductance of $3\text{–}5 \times 10^{-7}$ mho and was very constant. The specific conductance of the water in the cell during manipulation remained constant within a few units in the tenth place of decimals.

Test of Experimental Method. To test the reliability of the apparatus and procedure employed in the measurements, the conductance of solutions of potassium chloride was measured at concentrations between 1×10^{-4} and $1 \times 10^{-3}N$.[1] The results are shown in the first two lines of TABLE 1. The experimental values are reproduced by the equation:

$$\Lambda = 150.02 - 96.0\sqrt{C} \qquad (1)$$

with an average deviation of less than 0.01%.

If we assume Onsager's equation to hold and assume the specific conductance of a $1 \times 10^{-3}N$ solution of potassium chloride to be 146.98×10^{-6} and substitute in Onsager's equation, we obtain $\Lambda_0 = 149.98$. The equation becomes:

$$\Lambda_0 = 149.98 - 94.535\sqrt{C}. \qquad (2)$$

Conductance values computed according to equation (2) are shown in the third line of TABLE 1 and deviations $\Delta\Lambda$ in the last line. The average deviation is 0.012 Λ-unit, or less than 0.01 per cent.

The conductance of a considerable number of other salts has been measured, although with somewhat less care than was observed with KCl. In TABLE 2 are shown Λ_0 values computed according to the Onsager equation (column 2) and extrapolated values (column 3). Differences between the two are shown in the last column. The average difference is 0.03 Λ-unit, and positive and negative differences are nearly equal.

So far as present results are concerned, Onsager's equation holds within the limit of experimental error at concentrations below $1 \times 10^{-3}N$ for all the salts measured in these investigations. However, Shedlovsky[3] has found that, for KCl and some other salts, conductance values may be reproduced within the limits of experimental error up to a concentration of $0.01N$, or higher, by means of the equation:

$$\Lambda = \Lambda_0 - \alpha\sqrt{C} + (\alpha^2/\Lambda_0^2)C\Lambda. \qquad (3)$$

If we compute Λ_0 for KCl on the basis of equation (3) and a specific conductance of 146.98×10^{-6} at a concentration of $10^{-3}N$, we obtain $\Lambda_0 = 149.93$, a value 0.05 Λ-unit lower than that computed according to

TABLE 1

COMPARISON OF OBSERVED AND CALCULATED VALUES OF Λ FOR KCl IN WATER AT 25°*

$C \times 10^4$	1.1556	2.6924	5.2463	8.9078	10.092
Λ obs.	148.97	148.44	147.83	147.15	146.98
Λ calc.	148.97	148.43	147.81	147.16	146.98
$\Delta\Lambda$	0.00	+0.01	+0.02	−0.01	0.00
$C \times 10^4$	3.3448	5.0999	7.3643	8.9915	
Λ obs.	148.27	147.84	147.37	147.13	
Λ calc.	148.25	147.84	147.41	147.14	
$\Delta\Lambda$	+0.02	0.00	−0.04	−0.01	

* $\Lambda = 149.98 - 94.535\sqrt{C}$.

TABLE 2

EXTRAPOLATED AND CALCULATED Λ_0 VALUES (ONSAGER'S EQUATION)

Salt	Λ_0 (*Calc.*)	Λ_0 (*Extrap.*)	*Diff.* Λ_0
$KBrO_3$	129.24 ± 0.04	129.28	−0.04
Me_4NPi	75.31 ± 0.01	75.35	−0.04
Et_4NPi	63.05 ± 0.02	63.01	+0.04
Pr_4NI	100.25 ± 0.03	100.26	−0.01
Bu_4NBr	97.61 ± 0.02	97.57	+0.04
Am_4NBr	95.61 ± 0.01	95.62	−0.01
KBr	152.05 ± 0.01	—	—
KPi	103.96 ± 0.02	—	—

equation (2). While the difference between the two equations is small, it would seem that further careful measurements might resolve the question as to which equation is applicable in the concentration range of 1×10^{-4} to $1 \times 10^{-3}N$.

Conductance of Symmetrical Quaternary Ammonium Ions. Using the Λ_0 values of TABLE 2, the value 149.98 for the limiting conductance of KCl, and 0.4906 for the transference number[4] of the potassium ion in KCl, we obtain the ion conductances of TABLE 3. Values for the iodide and nitrate ions are derived from the conductance data of Shedlovsky.

It is of interest to note that the picrate ion, with 16 atoms other than hydrogen, is but a little poorer conductor than the tetraethylammonium ion with 9 atoms and a much better conductor than the tetrapropylammonium ion with 13 atoms.

We are particularly interested in the conductance of the quaternary ammonium ions. In order to study the effect of added carbon atoms on conductance, however, it is preferable to compare ion resistances rather than ion conductances, as Thompson[5] has suggested. Since we shall want to compare ion resistances in water with those of the same ions in other solvents, we shall compare values of the reciprocals of the conductance viscosity product, $1/\Lambda_0{}^+\eta$.

In FIGURE 1 are shown values of $1/\Lambda_0{}^+\eta$ for the five quaternary ammonium ions from tetramethyl- to tetra-*n*-amylammonium, inclusive, as well as for the ammonium ion. In the same figure are shown resistance curves for the same ions in ethylene chloride, nitrobenzene, and pyridine.[6]

It will be noted that, with increasing number of carbon atoms in an ion, its resistance in water increases much more than it does in other solvents. In water, the smaller ions have a much lower resistance than in other solvents; the larger ions have a much larger resistance. It is of interest to note that the resistance change on replacing four hydrogen atoms by four methyl groups differs little from that which results on adding four methylene groups to a large ion.

Long Chain Ions. It is of interest to study the effect of chain length in the case of ions such as the alkyltrimethylammonium ions. If the alkyl chain of an ion contains eight or more carbon atoms, solutions of its salts exhibit colloidal properties at concentrations above what is known as the critical concentration. It is commonly assumed that, at concentrations above the critical, the long chain ions form aggregates or "micelles," as they are called. At concentrations below the critical, salts of long chain ions have been looked upon as normal electrolytes. We have investigated the behavior of these salts at low concentrations and have found that salts of ions having chains of sixteen or more carbon atoms are not normal electrolytes.[7, 8]

TABLE 3

ION CONDUCTANCES BASED ON Λ_0 for $K^+ = 73.58$

Ion	$\Lambda_0 i$	*Ion*	$\Lambda_0 i$
Cl^-	76.40	K^+	73.58
Br^-	78.47	Me_4N^+	44.93
I^-	76.80	Et_4N^+	32.67
NO_3^-	71.38	Pr_4N^+	23.45
BrO_3^-	55.66	Bu_4N^+	19.14
Pi^-	30.38	Am_4N^+	17.14

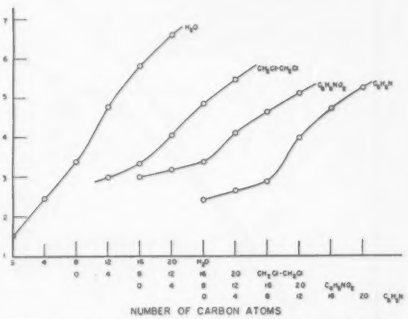


FIGURE 1. Resistance curves of quarternary ammonium ions (values of $1/\Lambda_0{}^+\eta$).

A. *Slope of Λ-$\sqrt{C}$ Plots.* In the case of normal electrolytes, the slopes of the Λ-$\sqrt{C}$ plots conform to Onsager's equation. With chain lengths of less than 16 carbon atoms, the slopes are normal; with 16 carbon atoms or more, the observed slopes are greater

than the theoretical. In TABLE 4 are presented limiting conductances for a number of 1–1 salts of long chain ions. In the third column are shown the observed slopes, in the fourth, the theoretical slopes for 1–1 salts, and, in the last column, the ratio of observed to theoretical slope. For the last salt in the table, the slopes are also compared, assuming a 2–1 electrolyte.

For ions having chains of 16 or more carbon atoms, the slopes for some salts approximate those of 2–1 salts. For the last salt in the table, the slope is markedly greater than that of a 2–1 salt. It is of interest to note that the observed slope is markedly dependent on the size of the three substituent alkyl groups of the long chain ions.

TABLE 4
SLOPES OF LONG CHAIN SALTS

Salt	Λ_0	*Slope Obs.*	*Slope Theor.*	*Ratio*
$C_{12}H_{25}(CH_3)_3N\ NO_3$	93.86	81.7	81.7	1.00
$C_{14}H_{29}(CH_3)_3N\ NO_3$	92.50	82.2	82.2	1.00
$C_{16}H_{33}(CH_3)_3N\ NO_3$	92.20	142	81.3	1.75
$C_{18}H_{37}(CH_3)_3N\ NO_3$	91.34	143	81.1	1.76
$C_{16}H_{33}(C_4H_9)_3N\ BrO_3$	72.38	199.4	76.8	2.59
			142.9*	1.40

* For 2-1 Salt.

TABLE 5
CONDUCTANCE OF LONG CHAIN IONS

Ion	Λ_0^+	*Ion*	Λ_0^+
$C_2H_5(CH_3)_3N^+$	40.51	$C_{12}H_{25}(CH_3)_3N^+$	22.39
$C_4H_9(CH_3)_3N^+$	33.26	$C_{14}H_{29}(CH_3)_3N^+$	21.16
$C_6H_{13}(CH_3)_3N^+$	29.23	$C_{16}H_{33}(CH_3)_3N^+$	20.82
$C_8H_{17}(CH_3)_3N^+$	26.21	$C_{18}H_{37}(CH_3)_3N^+$	19.96
$C_{10}H_{21}(CH_3)_3N^+$	24.00	$C_{16}H_{33}(C_4H_9)_3N^+$	16.72

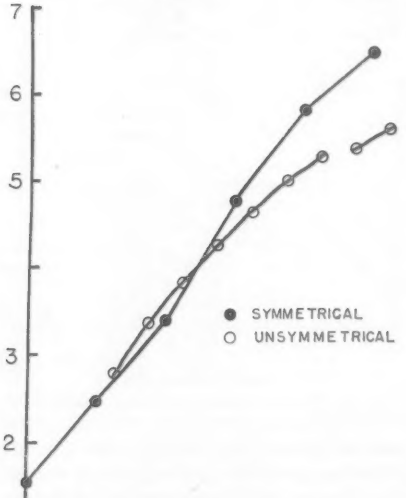


FIGURE 2. Resistance curves of symmetrical and of alkyltrimethylammonium ions (values of $1/\Lambda_0^+\eta$).

The steep slopes of the Λ-$\sqrt{C}$ plots might be accounted for by assuming ion-pair formation. Such interaction seems doubtful, however, in view of the fact that the corresponding dodecyl and tetradecyl derivatives exhibit a normal behavior. It seems more probable that, when chains reach a length of 16 or more carbon atoms, two (or perhaps more) chains associate, thus simulating an electrolyte of higher type.

B. *Ion Conductances.* In TABLE 5 are presented conductance values for alkyltrimethylammonium ions from ethyltrimethyl- to octadecyltrimethylammonium in steps of two carbon atoms per chain.[7,8] The conductance of the hexadecyltributylammonium ion is also given. The effect of chain length on ion conductances will be better understood by reference to FIGURE 2, in which equivalent resistances ($1/\Lambda_0^+\eta$) are plotted as a function of the total number of carbon atoms in the ion. Similar values

are also shown for the symmetrical quaternary ammonium ions.

It will be observed that the resistances of the ethyltrimethyl-, butyltrimethyl-, and hexyltrimethylammonium ions are somewhat larger than those of corresponding symmetrical ions. The two curves cross at a point that corresponds approximately to a heptyl derivative of a total of 10 carbon atoms. Beginning with the octyl derivative, the resistance increase with increasing number of carbon atoms is much smaller than it is for corresponding symmetrical ions.

There is a break in the resistance curve between the tetradecyl and the hexadecyl derivative. Such a break was not unexpected, in view of the fact that the ions of longer chains appear to be associated and the equivalent resistance of a multiply charged ion should be less than that of corresponding singly charged ions.

Conductances at High Field Strengths. As Wien has shown, when conductances are measured at higher fields, higher conductances are obtained, the magnitude of this effect being dependent on the nature of the electrolyte. For normal 1–1 salts, the limiting effect at very high fields corresponds to the conductance changes at lower potentials in going from a given concentration to the limit approached as the concentration decreases without limit. In practice, the resistance of a given electrolyte is balanced against that of potassium chloride at the same concentration. With normal 1–1 salts, the resistance change is the same as that of potassium chloride. With 2–1 salts, or higher, the resistance change is markedly greater than that of potassium chloride. It seemed that measurements of this kind with long chain salts might throw light on the results obtained by conductance measurements at low fields.

In FIGURE 3, the conductances of tetradecyltrimethylammonium salts are compared with that of potassium chloride up to field strengths of approximately 100 kilovolts per centimeter[9]. It will be noted that the conductances of the three salts are the same at different fields within the limit of experimental error.

In FIGURE 4 are shown conductance values for hexadecyltrimethylammonium nitrate and magnesium chloride[9] as a function of field strength at a concentration of $4 \times 10^{-4}N$. As may be seen from the figure, the two salts show the same conductance increase with field strength. At a field of 100 K.V./cm., the conductance increase is approximately 1 per cent. We

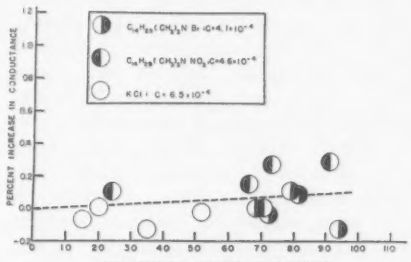


FIGURE 3. Conductance of tetradecyltrimethylammonium salts as a function of field strength.

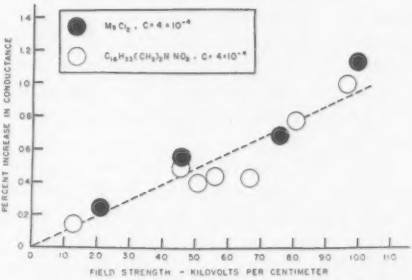


FIGURE 4. Conductance of hexadecyltriphenylammonium nitrate as a function of field strength.

may conclude that salts of ions having a chain length of 16 or more carbon atoms behave like electrolytes of higher type.

References

1. DAGGETT, H. M. 1949. Thesis, Brown University.
2. KUHN, D. W. 1949. Thesis, Brown University.
3. SHEDLOVSKY, T. 1932. J. Am. Chem. Soc. **54**, 1405.
4. LONGSWORTH, L. G. 1932. J. Am. Chem. Soc. **54**, 2741.

5. THOMPSON, W. E. 1941. Thesis, Brown University.
6. PICKERING, H. L. 1949. J. Am. Chem. Soc. 71: 3288.
7. BAIR, E. J. 1949. Thesis, Brown University.
8. MCDOWELL, M. J. Unpublished observations in the Brown Laboratories.
9. GUSMAN, S. Unpublished observations in the Brown Laboratories.

SECTION OF ANTHROPOLOGY

VERO AND MELBOURNE MAN: A CULTURAL AND CHRONOLOGICAL INTERPRETATION*

By IRVING ROUSE†

In 1915 and 1916, human remains were found at Vero on the east coast of Florida in apparent association with the bones of Pleistocene animals (Sellards and others, 1917). Other such associations were obtained at Melbourne, 33 miles to the north, in 1923–29 (Gidley, 1929). These finds have aroused considerable controversy. Most of the paleontologists interested in them have assumed that the human remains were laid down at the same time as the Pleistocene animal bones, while most of the anthropologists have argued, on the contrary, that the human remains are intrusive into the Pleistocene strata and were deposited during a more recent period. Since both parties to the controversy have been able to cite data in favor of their viewpoint, the problem has never been satisfactorily resolved.

The writer recently had occasion to make a survey of the archeology of the Indian River area, in which the Vero and Melbourne sites are situated (Rouse, n.d.). While this survey was not directed specifically towards the problem of Vero and Melbourne Man, its results seem to have some bearing upon the problem, and the present paper is intended to discuss them from this standpoint.

First, it will perhaps be well to review the facts and theories concerning Vero and Melbourne Man. The three most recent geological formations in the Indian River area are, successively, the Anastasia, Melbourne, and Van Valkenburg (Cooke, 1945: 265 ff.). The first consists primarily of sand mixed with marine shells and was apparently laid down at a time when this part of Florida was under the ocean. The second, or Melbourne formation (also called Pamlico), is a land deposit, consisting of sand and a remarkably rich assemblage of animal bones, many of which represent species which became extinct at or after the close of the Pleistocene epoch. The Van Valkenburg formation, finally, is composed of muck and the bones of animal species still existing in the region today. (The few bones of extinct animals found in it are believed to be intrusive; Sellards, 1947: 964.)

Both the Anastasia and Melbourne and the Melbourne and Van Valkenburg strata are separated by unconformities. It follows that five intervals of geologic time are represented in the area: (1) an Anastasia interval, in which the sea was high enough to cover this part of Florida; (2) an interval which we shall call Anastasia-Melbourne, in which the sea had fallen to such an extent that the area became dry and was subject to erosion, causing the first unconformity; (3) a Melbourne interval, in which the sea again rose, but not high enough to cause any great amount of inundation; (4) a Melbourne-Van Valkenburg interval, in which a second lowering of the sea, accompanied by a fall of the water table in the interior, again exposed the land to erosion and caused the second unconformity; and (5) a Van Valkenburg interval, in which the sea and the water table rose a third time, producing the swampy conditions which prevail in the area today—or did prevail until the construction of drainage canals (Rouse, n.d.).

* This paper, illustrated with Kodachrome slides, was presented at the meeting of the Section, April 24, 1950. The research upon which this paper is based was undertaken in connection with the Caribbean Anthropological Program of Yale University by means of a grant from the Viking Fund, Inc.

† Department of Anthropology, Peabody Museum of Natural History, Yale University, New Haven, Conn.

No human remains are associated with either the Anastasia or the Anastasia-Melbourne interval. Both artifacts and human skeletal material have been found in the Melbourne deposits. They include several stemmed flint projectile points, flint chips, bone awls, and bone pins; a human cranium at the Melbourne site; and a few miscellaneous human bones at Vero. The last appear to form part of a much larger group of bones, including the cranium of Vero Man, which was found on top of the plane of contact between the Melbourne and Van Valkenburg formations and can therefore be correlated with the Melbourne-Van Valkenburg interval. Finally, potsherds, additional flint points and chips, bone awls, and bone pins; some other bone implements; and further human bones were obtained from the uppermost, Van Valkenburg layer (Sellards, 1937).

It is the finding of artifacts and human bones in the Melbourne formation, in apparent association with the bones of Pleistocene animals, which has aroused controversy. Three hypotheses have been advanced to explain this association. First, there is the possibility that man settled Florida during the Melbourne period and deposited his remains at the same time as the animal bones; in fact, he may have caused the extinction of the animals. Secondly, it has been postulated that man, first appearing on the scene during a later period, deposited his remains on the contact plane or in the Van Valkenburg formation and that these remains subsequently became mixed with the Melbourne material, possibly, as Chamberlin (1917) has suggested in the case of the Vero site, by a churning action of the streams which run through the sites. Finally, it has been argued that the remains represent burials made in modern times by Indians who dug through the Van Valkenburg layer, the Melbourne-Van Valkenburg unconformity, and into the Melbourne formation.

The third explanation was advanced by Hrdlička (1917) and, so far as the writer is aware, only by him. It is not in accord with the facts and can therefore be disregarded. The problem, then, is whether the human remains were deposited in the Melbourne bone bed at the time of its formation or became mixed in it at a later date by some such means as that suggested by Chamberlin.

The principal difficulty in the way of solving this problem is that, with one possible exception, the human remains are secondarily deposited. As already stated, they do not represent burials. Neither can they be considered refuse. Instead, they are derived from burial or refuse sites which are no longer in existence. If we knew the relation of these sites to the Melbourne or Van Valkenburg formations, we could solve the problem; in the absence of this knowledge, we cannot.

Let us turn, then, to the evidence provided by the primary sites still extant in the area, of which 202 are known as the result of our recent survey. We shall first consider these from an archeological rather than a geologic standpoint, *i.e.*, in terms of a sequence of cultural periods. Six of these periods are now known for the Indian River area: Preceramic, Orange, Malabar I, Malabar II, St. Augustine, and Seminole. Since the last two are entirely historic, they can, for our purposes, be disregarded. The others may be briefly characterized as follows.

In the Preceramic period, the principal artifacts were stemmed flint projectile points, possibly stone vessels, bone awls and pins, socketed antler projectile points, and shell gouges. In general, these fall within the range of the Preceramic horizons in other parts of the Southeast, *e.g.*, the Mt. Taylor period on the lower St. Johns River (Goggin, MS) and the Lauderdale period in the Tennessee Basin (Webb and DeJarnette, 1942), for which a date immediately preceding 500 A.D. has been estimated.

The Orange period is distinguished by the addition to the Preceramic complex of fiber-tempered clay pottery of the Orange Plain and Incised types (Griffin, 1945). Several new artifact forms, such as shell dippers and

celts, also make their appearance. This period is related to a number of others throughout the Southeast which have been termed "Archaic" and are dated between 500 and 750 A.D.

During the Malabar I period, the fiber-tempered pottery develops into chalky ware of the St. Johns Plain, St. Johns Incised, and Dunns Creek Red types (Rouse, n.d.). (There are some grounds for subdividing this period into Malabar I and I′ on the basis of the presence and absence of St. Johns Incised pottery, but this need not concern us here.) So far as is known, all other forms of artifacts survive and a few new ones are added, notably the stone celt and shell pick. Burial mounds are absent or, at the most, very rare, but the period is definitely related to the Burial Mound horizons elsewhere in the Southeast and therefore may be dated between 750 and 1150 A.D.

The Malabar II period, finally, is marked by the disappearance of St. Johns Incised pottery and the rise to predominance of St. Johns Check Stamped. Burial mounds are definitely present. Stone vessels go out of use, but stone celts, bone awls and pins, socketed antler projectile points, and shell celts, gouges, picks, and vessels continue from the previous period. A series of new types, such as grooved stone pendants and engraved shell gorgets, make their first appearance.

It is clear that the Malabar II period, beginning about 1150 A.D., survived the coming of the Spaniards. Indeed, far from degenerating in the Colonial period, the native cultural complex was enriched by the addition of trade objects and of ornaments made of gold and silver looted from the wrecks of Spanish treasure ships. This, however, is another story.

From the standpoint of Vero and Melbourne man, it is important to note that the types of artifacts found in the Melbourne bed—projectile points, awls, and pins—are present throughout the cultural sequence, beginning in the Preceramic period and continuing well into historic times. They are of no use, therefore, as time markers. The absence of pottery in the Melbourne bone bed (with one possible exception) does suggest the Preceramic period, but this is not too reliable a point, since the deposit is secondary.

If we attempt to make the correlation on the basis of physical type rather than culture, we obtain a similar result. As Stewart (1946) has pointed out, Vero and Melbourne Man are physically of an earlier type than that represented in the burial mounds, *i.e.*, during Malabar II and possibly also the Malabar I period. We have no knowledge of the local physical type during the Preceramic and Orange periods, but elsewhere in the Southeast it corresponds to that of Vero and Melbourne Man. Therefore, on physical as well as cultural grounds, Vero and Melbourne man may be provisionally correlated with the Preceramic period, or possibly with the succeeding Orange period.

Let us next examine the relationship between the cultural and geologic periods. Evidence for doing this is found at several sites on the upper St. Johns River, notably Palmer-Taylor and South Indian Field. At these sites, as at Vero and Melbourne, three geologic formations are represented: (1) an underlying layer of marine shells, apparently the Anastasia of the coast; (2) the so-called Plummer loamy sand, which seems to correspond to the Melbourne bone bed (in fact, Melbourne fossils are reported to have been found in it); and (3) a top layer of muck, which is apparently the same as the Van Valkenburg formation on the coast (Rouse, MS).

At the Palmer-Taylor site, Preceramic refuse rests directly on the Plummer sand, whereas Malabar II material is found in association with the muck. At South Indian Field, Orange refuse lies on the sand, while some Malabar II specimens are included in the muck. There are similar indications at other sites that both the water table and the sea level were lower during the Preceramic and Orange periods than in the later periods (with the possible exception of Malabar I: Rouse, n.d.). We may there-

fore correlate the first two cultural peroids with the Melbourne-Van Valkenburg interval and the last three with the Van Valkenburg interval, as in TABLE 1.

Further evidence in favor of these correlations is supplied by the presence at both South Indian Field and the Melbourne Golf Course site of a series of small basins which, in the case of South Indian Field, appear to have been dug by Indians of the Orange period. At South Indian Field, these basins underlie the muck and extend down through the sand into the Anastasia formation. As a result, Orange and Malabar refuse, which has apparently washed into them since their abandonment, lies in hollows in the Anastasia stratum, well below the level of the Melbourne formation (Rouse, n.d.). At Melbourne, the basins are likewise on the surface of the Melbourne formation, underlying the muck, and can therefore be directly associated with the Melbourne-Van Valkenburg period (Gidley, 1929). For lack of a better hypothesis, we believe that they represent wells dug by the Indians during the Melbourne-Van Valkenburg period of low water.

Thirdly, it should be noted that no bones of extinct animals have been found in any of the Preceramic and Orange sites. There are two exceptions, both horse-teeth obtained from Orange refuse at South Indian Field, but these appear to have been picked up as fossils by the Indians (Rouse, n.d.). Thus, all the Indian occupations must be considered later than the Melbourne interval.

Correlation of the Preceramic and Orange cultural periods with the Melbourne-Van Valkenburg interval provides an indirect means of dating Vero and Melbourne Man. If, as we have indicated, Vero and Melbourne Man are Preceramic or possibly of the Orange period, it follows that they must have been contemporaneous with the Melbourne-Van Valkenburg interval. In other words, they are to be equated with the unconformity between the Melbourne and Van Valkenburg formations.

We are thus led to the conclusion that the Vero skull, which was found on the contact plane between the Melbourne and Van Valkenburg formations, represents the true state of deposition, while the Melbourne skull and the other material found in the Melbourne stratum at both Vero and Melbourne are intrusive. We suggest that Vero and Melbourne Man lived on the contact plane during the Melbourne-Van Valkenburg interval and introduced both bones and artifacts into the underlying Melbourne formation by making burials and digging wells, into which some artifacts and bones may subsequently have fallen, as they did at South Indian Field.

TABLE 1

CORRELATION OF THE GEOLOGIC INTERVALS AND CULTURAL PERIODS IN THE INDIAN RIVER AREA

Geologic intervals	*Cultural periods*
Van Valkenburg	Seminole
	St. Augustine
	Malabar II
	Malabar I
Melbourne-Van Valkenburg	Orange
	Preceramic
Melbourne	
Anastasia-Melbourne	—
Anastasia	

A final word concerning the age of the Melbourne-Van Valkenburg period. It is assumed by most geologists that the height of the east coast of Florida has not changed since the middle of the Pleistocene and that the rise in sea level which took place at the close of the Melbourne-Van Valkenburg period was therefore entirely eustatic (*e.g.*, Cooke, 1945: 245). If this is so, it reflects the last major world-wide change in the level of the sea. According to Godwin (1940: 287, Figure 31), this took place in southern England, where conditions are

also entirely eustatic, between 2000 B.C. and 0 A.D. If our correlations are correct, Vero and Melbourne Man, as well as the Preceramic and Orange cultures, should have been in existence during the same period.

Bibliography

CHAMBERLIN, R. T. 1917. Further studies at Vero, Florida. J. Geol. **25:** 667–83.

COOKE, C. W. 1945. Geology of Florida. Geol. Bull. Florida Geol. Surv. 29.

GIDLEY, J. W. 1929. Ancient man in Florida: further investigations. Bull. Geol. Soc. Am. **40:** 491–502.

GODWIN, H. 1940. Studies in Post-glacial History of British Vegetation: III Fenland pollen diagrams; IV Post-glacial changes of relative land and sea-level in the English fenland. Phil. Trans. Roy. Soc. of London B, **230.**

GOGGIN, J. M. Space and time perspective in northern St. Johns archeology. Manuscript in the Yale Peabody Museum, New Haven.

GRIFFIN, J. B. 1945. The significance of the fiber-tempered pottery of the St. Johns area in Florida. J. Wash. Acad. Sci. **35:** 218–23.

ROUSE, I. A Survey of Indian River Archeology, Florida. Yale University Publications in Anthropology, no. 44. In press.

SELLARDS, E. H. 1937. The Vero finds in the light of present knowledge. In "Early Man," edited by George Grant MacCurdy: 193–210. Lippincott. Philadelphia.

SELLARDS, E. H. 1947. Early man in America: index to localities and selected bibliography, 1940–1945. Bull. Geol. Soc. Am. **58:** 955–78.

SELLARDS, E. H., *et al.* 1917. Symposium on the age and relations of the fossil human remains found at Vero, Florida. J. Geol. **25:** 1–62.

STEWART, T. D. 1946. A re-examination of the fossil human skeletal remains from Melbourne, Florida with further data on the Vero skull. Smithsonian Miscellaneous Collections **106** (10).

WEBB, W. S. & D. R. DEJARNETTE. 1942. An archeological survey of the Pickwick Basin in adjacent portions of the states of Alabama, Mississippi, and Tennessee. Bureau of American Ethnology, Bull. 129.

*DIVISION OF MYCOLOGY**

MYCOLOGICAL PROBLEMS IN DETERIORATION OF MILITARY EQUIPMENT†

By WALTER N. EZEKIEL‡

Deterioration of military materiel during World War II resulted in recognition of a new border-line field of scientific knowledge concerned with such diverse matters as the etching of lenses of binoculars by fungus growth, the quick failure of signal equipments taken into the tropical jungles, the moisture and fungus damage that caused inaccurate aiming and erratic operation or failure of electrical power drives of anti-aircraft guns in the Philippines and aboard ship, as well as the more familiar rotting of cloth used in tents and for camouflage.

Because of the dramatic damage in the tropical areas, the term "tropical deterioration" was sometimes used to designate the trouble, and the accompanying term, "tropicalization," for preventive treatments applied in attempts to prevent the deterioration.[1] Information gathered since the war, to the effect that moisture and microorganisms, particularly fungi, can and do cause just as serious damage (if not quite so rapidly) in areas far from the equator, has made it desirable to drop the names mentioned in favor of terms such as "moisture and fungus proofing" and "deterioration prevention." It is important that people responsible for design and maintenance of some industrial and consumer goods, as well as of military items, should not believe that protection of this kind is necessary only for equipment destined for a tropical environment.[2]

Moisture and Fungus Damage to Materiel. The story of damage to materiel has been gradually becoming known since World War I, when trouble was noticed on optical instruments. Vision through binoculars and telescopes was obscured by lush fungus

* The Section of Oceanography and Meteorology held a meeting April 25, 1950, on "Objective Methods of Weather Forecasting." This was a forum discussion and no abstract has been received.

† This paper, illustrated with lantern slides, was presented at the meeting of the Division, April 28, 1950.

‡ Bureau of Ordnance, Navy Department, Washington 25, D.C.

growth, films of moisture, and eventual etching of lenses. Again, in World War II, the Australians, for example, reported that many optical instruments operated only four to eight weeks in the New Guinea campaign before they became infested by fungi and that binoculars shipped from Australia were often infested before they could be issued from the depots.[3] The situation was better with our larger optical systems on the ships. Moisture-proof construction of naval optical units had been developed to meet this hazard, and there was relatively little deterioration of these reasonably well-sealed optical systems.[4]

The fact that textile products and lumber are subject to decay was also known before the war, and a background of some practical answers in this field was fortunately available from prior agricultural and industrial research. Further research under the impetus of the war improved treatments to protect tentage, tarpaulins, sandbags, and camouflage materials from rapid decay. Complicated combined treatments were developed and embodied in specifications, so that canvas, for example, might simultaneously be made resistant to fungi, to fire, and to water, while being dyed to a desired color.[3]

More unexpected during World War II was the damage in connection with the increasing use of electrical and electronic communication, detecting, computing, directing, and other mechanisms used ashore and afloat. The Signal Corps and the Marines found that signal equipment taken into the jungles might go out of action within a few hours. Mold growth enveloped wires, and soft plastic parts took up moisture so that they warped out of shape and became conductors instead of insulators.

Emergency protective treatment was introduced in both maintenance and production as early as 1942.[1, 5] This "tropicalization" treatment consisted of coating all possible surfaces with a moisture-resistant lacquer or varnish which contained a fungistatic agent. In conjunction with other improvements, this superficial coating is still employed by most of the services.

Larger electrical units were also damaged. The Army Ordnance Department discovered that electrical portions of the power drive of the 90-mm. anti-aircraft guns in the Philippines were so damaged by fungi and moisture that operation became erratic and ineffective. Checking newer production still in this country, the same units were sometimes found to be profusely overgrown by fungi and with electrical values below those considered minimum for field operation.

Damage on shipboard electrical equipment was studied in 1945 in a survey of vessels at bases along the West Coast, from small LST's to battleships. Fungus growth was found in some of the electrical equipment on every vessel and in equipment going through the shops of every base. It was common in transfer switches, in gun directors, in the gun power drives, and particularly in the battle-telephone systems.[4] The obvious fungus growth and corrosion was in many cases connected directly with a story of operational difficulty. Damage had been found earlier[6] in the equipment of vessels from the North Atlantic run, as well as in those from the South Pacific. Some equipment became moldy while in shipment to naval bases in this country, so that overhauling was required before it could be installed on the vessels. An Air Force survey came back with a similar story[7] of considerable deterioration of equipment on planes and in storage at bases around the world.

In the years since the war, information has continued to accumulate on damage occurring in this country as well as elsewhere. Electrical units stored in Washington and Philadelphia have been seen with spectacular fungus growth. Equipment awaiting use at naval bases, or in transit, shows deterioration of the same nature as that seen on units from the South Pacific. Improvement to prevent such attack is therefore considered necessary as a regular part of production of military materiel.

Exploration of deterioration problems and some basic and more applied research on means of preventing the damage have been carried out by relatively small groups working primarily in military laboratories or in university and industrial laboratories under research contracts with military agencies. In the present paper, the writer does not intend to go into the detailed results of these researches (except as they may be pertinent to some particular discussion) but will present some generalizations, which are possible now as a result of the accumulated information, with regard to analyses of problems of deterioration and to action that may be attempted. These generalizations include the various effects of fungi and moisture on materials and equipment, the different approaches that may be followed in attempting to prevent damage, and the kind and reliability of procedures for research and later for routine specification tests that may be involved in determining whether a particular material or treatment attains the selected goal.

A Classification of Effects of Fungus Growth. Deterioration of materials and equipments can be classified as resulting from several different kinds of effects. Failure to visualize all of these possibilities may cause only partial analysis of a problem and lead to mistaken ideas as to the relative importance of protection of equipment from the combined action of fungi and moisture.

(1) *Visible decomposition and obvious failure, of a particular isolated material or of that portion of a larger unit upon which the fungus growth is seen.* This would appear to be the simplest type of microbiologic damage. It would cover such familiar examples as the decay of fabrics used for sandbags, under conditions that induced visible fungus growth and obvious shredding away of the fabric, or the visible decay and failure of lumber. The fungus growth itself need not necessarily be readily visible as the cause of such an obvious failure to fit this classification.

(2) *No visible decomposition but a demonstrable effect on one or more important properties of the affected material or part.* This classification would cover a wide range of effects on military material. Fungi may produce an obvious or less obtrusive growth without causing an obvious disintegration of the substratum but with effects, such as changes in strength, color, flexibility, or electrical insulating values, that make the apparently unimpaired substratum of significantly lessened usefulness.

Some examples of this kind of effect have already been mentioned. With optical instruments, growth over lenses obscured vision and thereby impaired operation of the instruments long before chemical action by the fungi had caused etching of the lenses. Another example is the moldy shower curtain, which may be discarded because of permanent discoloration some time before it need be discarded because of weakness. Similarly, projection screens are damaged by discoloration from fungus growth rather than by disintegration.[3]

Extensive studies by Luce and Mathes[8] have indicated that electrical values of hook-up wire, particularly surface insulation resistance, may deteriorate sharply before there is visible mold growth. This effect is considered to be due to subvisual growth, with the interlacing germ-tubes providing electrical leakage paths over the surface of the wire. Work with coated fabrics (such as those used in raincoats) has brought out the conclusion that fungus growth on and in such materials is damaging, not from direct loss of tensile strength, but as a result of loss of flexibility of the fabric, which causes it to crack more readily.[9]

(3) *Damage to portions of an equipment other than that upon which the growth occurs.* This is not necessarily accompanied by either kind of effect noted upon the particular part that supports the fungus growth. The part supporting growth may show neither obvious disintegration nor reduction

in its own required performance characteristics, yet the effect on other parts may be sufficient to prevent the unit as a whole from operating.

In the case of electrical and electronic equipment, damage of this kind is common. Such nutrient materials as braid-covered hook-up wire and relatively soft fabric- or wood-flour-filled plastics may support profuse fungus growth. It is well known that fungus growth is accompanied by excretion from the mycelium of various salts, of enzymes and other organic materials, including organic acids, and later of alkaline staling products. This complex of products of fungus metabolism has a profound effect on metal surfaces nearby, enormously accelerating corrosion. Furthermore, fungus spores produced on portions of units such as those mentioned may shed profusely over other portions and cause unexpected damage there.

This general damage to equipment is frequently seen on synchro motors and generators and on larger motors. Braid-covered wires leading into these units serve as a path for fungus growth. There is usually little material within the motor on which molds can grow, but the growth around the wire serves as a center around which rotor and stator surfaces become corroded.

An instrument observed in Washington showed profuse mold growth enveloping plastic and cotton-braid covered wire near the top. Showers of spores drifting down from these portions had settled over the lower portions of the instrument. Continued germination of these spores had resulted in numerous specks of corrosion over the aluminum surfaces, and had also produced a continuous weft of growth over the ceramic and bare chromel wire in heater elements near the base of the instrument.

More extreme general effects, as compared to the extent of the moldy portion of the unit, were seen by the writer in the case of a new fire-control unit returned to the manufacturer for rebuilding. This unit showed a relatively small amount of fungus growth on small lengths of hook-up wire and on plastic. But the mycelium extended to nearby bronze spring contacts, which had become severely corroded, as had also gears and other mechanical parts directly below the moldy portions, so that the unit was disabled. Exactly similar gears and other metal parts, at a distance from the moldy parts but within the same enclosure, were scarcely discolored. Thus, the severe corrosion which disabled this unit before it could be installed on the ship was due specifically to the effect of the fungus and not just to moisture.

Goals in Work on Fungus Resistance. There are several approaches toward increased resistance of materials and equipment to fungi and moisture. One obvious approach is to keep material dry all the time, thereby also preventing biological action. This is a large subject in itself, going into engineering design, hermetic sealing, desiccant units, ventilation of equipment, care in packaging, special maintenance, and the like. This engineering approach is not of primary interest here and need not be considered further, except to remark that it is generally not a substitute for inherent improvement of the parts of equipment, as will be discussed later. Even perfect gasketing and pressure-proof enclosure of instruments does not guard against breaking of the seal in military action (if not earlier, by vibration, accident, or carelessness) and rapid deterioration if the instrument has been built of parts that cannot withstand exposure to some moisture.

With increasing recognition of the need for fungus and moisture resistance on the part of materials used in equipment, there has been some confusion as to just what is wanted. In one specification, the requirement is that no "deleterious" fungi shall grow on the material covered, with no inkling as to what is considered deleterious, how it is to be recognized, or how a material can be tested for acceptability.

For use in research, and particularly as a

goal for later specification test methods, several interservice committees have officially adopted a summary of views recognizing the need for clear designation of specific objects in work on fungus resistance. These statements have pointed to the following separate goals that may be pursued just within the scope of electrical equipment and that need to be covered by appropriate test procedures:

(1) Inherent nutrient inertness (which the writer has recently designated as "funginertness") of a material or component.[2, 10] This characteristic refers to the relatively permanent property of not supporting fungus growth because the material, part, or component in question does not furnish the necessary nutrients, as distinct from resistance due to the presence of fungistatic or fungicidal agencies.

(2) Fungistatic (and/or fungicidal) effectiveness within materials or components.

(3) Fungistatic effectiveness of coating materials (varnishes or lacquers) to be applied over equipment and requiring test prior to such applications.

(4) Fungus and moisture resistance of a completed equipment or assembly. (This would be the final goal of the approaches above, but it would be determined by a different kind of test.) Tests of this kind cover general effects on equipments as a whole, which are not necessarily apparent from the work on the isolated materials or components.

This list could be extended by pointing to considerations of ability of a material or component to maintain a particular property, such as electrical insulation resistance,[8] in the presence of moisture and fungus growth.

The diversity of kinds of fungus resistance can be illustrated by the case of electrical insulated wire. Recently, use of wire with an extruded nylon jacket, instead of a braid, has been encouraged, partly on account of its fungus resistance.[11] The nylon jacket is funginert and also maintains good electrical properties in the presence of moisture. Still older specifications called for fungistatic coating of braid-covered wire, with appropriate tests to prove presence of the fungistatic chemical.[12] Recognition of the newer goal led to adoption of an appropriate test.

Test Procedures and Specifications. This discussion has gone into the recognition of the kind of fungus resistance desired and the selection of research procedures, specification requirements, and tests that will approach the desired goal. It is particularly unfortunate when the body of a specification announces that a material is desired that does not support growth (*i.e.*, one that is funginert), while the test method given requires presence of an active fungistat.[13] A first consideration with test procedures, then, is clear decision as to what is desired and how it can be recognized. Examples of fungus resistance tests aimed at particular goals are available in some specifications.[11]

Another consideration particularly applicable to the official specifications or contracts by which particular products are purchased or manufactured is the practical recognition of what can be obtained. For procurement at a particular time, there is little point in a specification requirement that is a research goal and for which the answer is not known. From the viewpoint of both research and procurement, it appears desirable to separate clearly these two matters.

The reliability of test procedures in these relatively new areas of mycological work is another matter in which attention is necessary. Consistency of results by a particular laboratory procedure is no insurance that the true answer is being obtained. For example, in considering fungistatic agents for coating materials to be used on electrical equipments, it has been discovered that ratings by a rather well-standardized laboratory procedure do not agree with field exposure tests.[14] Of three fungistatic agents often used, pentachlorophenol was effective by laboratory qualification but in field exposure of treated material proved to be fungistatic for only a brief period. Phenyl mercuric salicylate was outstanding under

laboratory conditions, with thermostability suggesting a long life, yet under field conditions it was not effective for as long a period as salicylanilide, which had barely qualified in the laboratory. These results point to a need for consideration and selection of these particular materials by comprehensive study beyond that possible in the prior routine specification test.

Importance of Practical Application. Despite the need for further information in many directions, which is obvious from the general matters discussed, it is desirable to apply immediately the concepts of resistance to moisture and fungus damage. Particularly for military equipment, the practical benefit to be obtained by selection of the better of materials available is so great that this should be done without delay. In many cases, it may be possible to obtain considerable improvement at little if any additional cost simply by excluding some of the poorer materials that are still being used.

Summary. (1) Fungi and moisture have caused extensive damage to military materials and equipment. Deterioration of this kind was common during World War II in tropical areas and also on similar units in this country and in vessels from the North Atlantic run.

(2) Fungus damage may consist of visible decomposition and obvious failure of particular materials or parts; degradation in some important characteristic without visible decomposition of the affected material or part; and damage to portions of an equipment beyond that upon which the growth occurs.

(3) The necessity is pointed out for clear recognition of general goals, such as funginertness as compared to fungistatic or fungicidal properties of a material. Research and specification test procedures should be appropriate both to the general approach and to the particular material.

References

1. Signal Corps U. S. Army. 1944. This Is serious. Tropicalization, Why, How, What.
2. Ezekiel, W. N. 1950. Problems in fungus and moisture deterioration. Electrical Manfacturing **45** (3): 78–85, 178–190.
3. Tropical Deterioration Administrative Committee, NDRC. 1946. Summary Technical Report, **1** Tropical Deterioration of Equipment and Materials. Washington, D. C.
4. Ezekiel, W. N. 1946. Battleships and fungi. Paper before St. Louis Meeting, Myc. Soc. Amer.
5. 1943. Moisture- and fungus-resistant treatment of Signal Corps ground signal equipment (overall treatment of assembled equipment). Signal Corps Specification 71–2202.
6. Ezekiel, W. N. 1945. Fungus and moisture damage observed on electrical equipment on USS CL 81, and on equipment from smaller combatant vessels. (Confidential) Naval Ordnance Lab., Silver Spring, Rpt. 444.
7. 1946. Report of Army Air Forces tropical mission. Air Techn. Service Command.
8. Luce, R. H. & K. N. Mathes. 1948. Investigations of the effect of moisture and fungi in the deterioration of low voltage radio hook-up wire. Reports of work under Contract W28-099-ac69.
9. Harvey, J. V. 1949. Testing the fungal resistance of plastic coated fabrics and plastic films. Quartermaster General Laboratories Research Rpt., Microbiol. Ser. 13.
10. Ezekiel, W. N. "Funginert"—a designation for inherently fungus-resistant materiel. Science. In press.
11. Treatment, moisture- and fungus-proofing, of elements, components, and assemblies, electrical and electronic: general specification. Bureau of Ordnance Specification 52T15 (Ord).
12. 1949. Cable (hook-up wire), electric, insulated, radio and instrument. Joint Army-Navy Specification JAN-C-76, with Amendment 3.
13. Ezekiel, W. N. 1949. "Fungus resistance" test procedures for materiel. Paper before New York meeting, Myc. Soc. Amer.
14. Ezekiel, W. N. 1949. Laboratory versus field exposure test in choice of military fungistatic agents. Paper before New York meeting, Myc. Soc. Amer.

NEW MEMBERS

Elected April 27, 1950

LIFE MEMBERSHIP

Gomez-Villegas, Cesar, M.D., Bacteriology. Director, Serums and Vaccine Laboratory, National Institute of Health, Bogota, Colombia.

SUSTAINING MEMBERSHIP

Helson, Harry, Ph.D., Psychology. Chairman, Department of Psychology, Brooklyn College, Brooklyn, N. Y.

Stritzler, Conrad, M.D., Dermatology, Syphilology. Dermatologic Staff, Long Island College Hospital, Brooklyn, N. Y.

ACTIVE MEMBERSHIP

Arzt, Sholom, M.S., Mathematics. Instructor, New York University, New York, N. Y.

Adams, Andrew B., M.D., Anatomy. Instructor, Temple University Medical School, Philadelphia, Pa.

Applegit, Ruth L., M.A., Biology. Instructor, Adelphi College, Garden City, N. Y.

Azarnoff, Daniel L., M.S., Radiobiology. Research Assistant, Department of Anatomy, University of Kansas, Lawrence, Kansas.

Benditt, Earl P., M.D., Experimental Pathology. Assistant Professor, University of Chicago Clinics, Chicago, Ill.

Blumenfeld, Serge, M.D., Internal Medicine. Resident, Metropolitan Hospital, Welfare Island, N. Y.

Bond, Charles, M.A., Physiology. Instructor, Department of Zoology, University of Massachusetts, Amherst, Mass.

Brenowitz, Harry., M.A., Invertebrate Zoology. Instructor, Adelphi College, Garden City, N. Y.

Briody, Bernard A., Ph.D., Animal Viruses. Instructor, School of Medicine, Yale University, New Haven, Conn.

Burger, Jay, M.D., Neoplastic Disease. Associate Director, Clinical Laboratories of Newark Clinical Group, Newark, N. J.

Caiola, Fred, Ce. E., Physics. Designing Engineer, A. W. Dow Company, New York, N. Y.

Cefola, Michael, Ph.D., Analytical Chemistry. Assistant Professor, Fordham University.

Chessin, Max, B.S., Pharmacology, Biochemistry. Senior Pharmacologist, Warner Institute for Therapeutic Research, New York, N. Y.

Christakis, George J., B.A., Pharmacology. Assistant, New York Medical College, New York, N.Y.

Collins-Williams, Cecil, M.D., Pediatrics. Research Fellow, New York Medical College, New York, N. Y.

Cunningham, George L., Ph.D., Physical Chemistry. Associate Professor, University of Cincinnati, Cincinnati, Ohio.

del Rosario, Leticia, Ph.D., Nuclear Physics. Chairman, Department of Physics, University of Puerto Rico, Rio Piedras, P. R.

Eyzaguirre, Carlos, M.D., Neurophysiology. Fellow in Medicine, Johns Hopkins University, Baltimore, Md.

Frisco, William P., L.L.B., Synthetic Rubber, Plastics. Research Director, St. Clair Rubber Company, Marysville, Mich.

Giere, Frederic A., B.A. Physiology. Graduate Assistant, Department of Zoology, Syracuse University, Syracuse, N. Y.

Goett, E. J., Ch.E., Pharmaceutical Chemicals. Manager, Sales Development Department, Charles Pfizer & Company, Inc., Brooklyn, N. Y.

Goldin, Milton, M.S., Microbiology. Bacteriologist, Mt. Sinai Hospital, Chicago, Ill.

Gruhzit, Carl C., B.S., Pharmacology. Research Assistant, University of Michigan, Ann Arbor, Mich.

Hall, James C., Ph.D., Biology. Assistant Professor, Newark Colleges, Rutgers University, Newark, N. J.

Holden, Robert J., M.S., Biochemistry. Chemist, St. Vincent's Hospital, New York, N. Y.

Holfeld, Winfried T., M.S., Chemistry. Chemist, St. Vincent's Hospital, New York, N. Y.

Hoobler, Icie G. M., Ph.D., Chemistry, Biology. Director, Research Laboratory, Children's Fund of Michigan, Detroit, Mich.

Huleatt, William P., E.M., Economic Geology. Geologist, U.S. Geological Survey, Denver, Colorado.

Hutchinson, L. Charles, Ph.D., Mathematics. Associate Professor, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Imbriglia, Joseph E., M.D., Pathology, Physiology. Professor, Clinical Pathology, Hahnemann Medical College, Philadelphia Pa.

Kassel, Robert L., M.S., Cellular Physiology. Research Assistant, Department of Biology, New York University, New York, N. Y.

Keyes, Donald B., Ph.D., Chemical Engineering. Vice President in charge of Planning and Development, Heyden Chemical Corporation, New York, N. Y.

Kinney, Margaret M., M.L.S., Medicine. Chief Librarian, Veterans Administration Hospital, Bronx, N. Y.

Klarmann, Emil, G., D.Sc., Chemistry, Bacteriology. Vice President in Charge of Research, Lahn and Finle, Inc., Bloomfield, N. J.

Kley, Dorothy V., B.S., Bacteriology, Virology. Bacteriologist, Warner Institute for Therapeutic Research, New York, N. Y.

Krementz, Robert M., B.A., Pharmacology. Laboratory Assistant, Maltbie Laboratories, Morristown, N.J.

Lawlor, George F., Ph.L., Anatomy, Physiology. Assistant Professor, Department of Biology, Boston College, Boston, Mass.

Lanert, Tulita F., B.A., Bacteriology. Bacteriologist, Charles Pfizer & Company, Inc., Brooklyn, N. Y.

Lindenblad, Gordon E., B.S., Cytology. Technician, Department of Biology, Brookhaven National Laboratory, Brookhaven, L.I., N. Y.

Loewenthal, Lois A., B.A., Histophysiology. Graduate Student, Brown University, Providence, R. I.

Lombardi, Frank, Histological Techniques. Histology Technician, Merck Institute, Merck and Company, Rahway, N. J.

Lovins, Gerald H., E.E., Scientific Instruments and Apparatus. Owner, Lovins Engineering Company, Silver Springs, Md.

McLean, Edwin B., M.D., Hematology. Hematologist, Abington Memorial Hospital, Abington, Pa.

McNew, George L., Ph.D., Plant Pathology. Director, Boyce Thompson Institute, Yonkers, N. Y.

Orfuss, A. J., M.D., Medicine. Instructor, Dermatology and Syphilology, New York University, Bellevue Medical Center, New York, N. Y.

Petrocci, Alfonso N., B.S., Bacteriology. Bacteriologist, Johnson & Johnson, New Brunswick, N. J.

Quimby, Freeman H., Ph.D., Physiology. Acting Head, Physiology Branch, Biological Sciences Division, Office of Naval Research, Washington, D. C.

Reissmann, Thomas L., Ph.D., Organic Chemistry. Research Chemist, Ethicon Suture Laboratories, New Brunswick, N.J.

Riley, A. Kathleen, M.D., Dermatology. Private Practice, Charleston, S. C.

Rosenthal, Harold L., Ph.D., Biochemistry, Physiology. Research Assistant, Bureau of Biological Research, Rutgers University, New Brunswick, N. J.

Soberman, Alexander, D.D.S., Oral Medicine. Instructor, Department of Periodontia, College of Dentistry, New York University, New York, N. Y.

Stein, George, M.D., Medicine, Dentistry. Research Associate, Dentistry, Columbia University, New York, N. Y.

Talbot, Samuel A., Ph.D., Biophysics. Associate Professor, Medicine, Johns Hopkins Hospital, Baltimore, Md.

Thurston, John R., B.S., Bacteriology. Graduate Assistant, The Ohio State University, Columbus, Ohio.

Titelbaum, Sydney, Ph.D., Toxicology, Forensic Medicine. Toxicologist, Chicago Biological Research Laboratory, Chicago, Ill.

Vinson, Leonard J., Ph.D., Biochemistry. Chief Supervisor of Biological Research, Lever Brothers Company, Cambridge, Mass.

Vogel, Herbert, Ornithology. Bureau of Internal Revenue, New York, N. Y.

Werbin, Harold, Ph.D., Biochemistry. Chief Biochemist, Hillside Hospital, Bellrose, N. Y.

Whitehorn, William V., M.D., Medical Physiology, Experimental Medicine. Assistant Professor, College of Medicine, University of Illinois, Chicago, Ill.

STUDENT MEMBERSHIP

Bregman, Jacob I., M.S., Chemistry. Graduate Student, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Greenberg, Mortimer S., B.A., Biology, Medicine. Medical Student, Long Island College of Medicine, Brooklyn, N. Y.

Hamburgh, Max, M.S., Zoology. Laboratory Instructor, Columbia University. New York, N. Y.

Pope, Martin, B.S., Physical Chemistry. Research Fellow, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

Smitheman, Kent A., Biological Chemistry. Student, Rutgers University, New Brunswick, N. J.

Waxman, Monroe H., B.S., Physical Chemistry. Research Fellow, Polytechnic Institute, Brooklyn, N. Y.